Specimen Paper

GCE A LEVEL

MARK SCHEME

MAXIMUM MARK: 100

SYLLABUS/COMPONENT: 9702/04

PHYSICS
Paper 4

Section A

1 (a) (i) radial lines B1
pointing inwards B1

(ii) no difference *OR* lines closer near surface of smaller sphere B1 [3]

(b) (i) $F_G = GMm / R^2$ C1
$= (6.67 \times 10^{-11} \times 5.98 \times 10^{24}) / (6380 \times 10^3)^2$
$= 9.80$ N A1

(ii) $F_C = mR\omega^2$ C1
$\omega = 2\pi / T$ C1
$F_C = (4\pi^2 \times 6380 \times 10^3) / (8.64 \times 10^4)^2$
$= 0.0337$ N A1

(iii) $F_G - F_C = 9.77$ N A1 [6]

(c) because acceleration (of free fall) is (resultant) force per unit mass B1
acceleration $= 9.77$ m s^{-2} B1 [2]

2 (a) (i) $\omega = 2\pi f$ B1

(ii) (-)ve because *a* and *x* in opposite directions
OR *a* directed towards mean position / centre B1 [2]

(b) (i) forces in springs are $k(e + x)$ and $k(e - x)$ C1
resultant $= k(e + x) - k(e - x)$ M1
$= 2kx$ A0 [2]

(ii) $F = ma$ B1
$a = -2kx / m$ A0
(-)ve sign explained B1 [2]

(iii) $\omega^2 = 2k / m$ C1
$(2\pi f)^2 = (2 \times 120) / 0.90$ C1
$f = 2.6$ Hz A1 [3]

3 **(a)** single diode M1
in series with R *OR* in series with a.c. supply A1 [2]

(b) **(i)** **1** 5.4 V (allow ±0.1 V) A1

(i) **2** $V = iR$
$I = 5.4 / 1.5 \times 10^{3}$ C1
$= 3.6 \times 10^{-3}$ A A1

(i) **3** time = 0.027 s A1 [4]

(ii) **1** $Q = it$
$= 3.6 \times 10^{-3} \times 0.027$ C1
$= 9.72 \times 10^{-5}$ C A1

(ii) **2** $C = \Delta Q / \Delta V$ (allow $C = Q/V$ for this mark) C1
$= (9.72 \times 10^{-5}) / 1.2$
$= 8.1 \times 10^{-5}$ F A1 [4]

(c) line: reasonable shape with less ripple B1 [1]

4 **(a)** **(i)** 50 mT A1

(ii) flux linkage $= BAN$ C1
$= 50 \times 10^{-3} \times 0.4 \times 10^{-4} \times 150 = 3.0 \times 10^{-4}$ Wb A1 [3]
(*allow 49 mT* $\rightarrow$ *2.94* $\times$ *10*$^{-4}$ *Wb or 51 mT* $\rightarrow$ *3.06* $\times$ *10*$^{-4}$ *Wb*)

(b) e.m.f. / induced voltage (*do not allow current*)
proportional/equal to B1
rate of change/cutting of flux (linkage) B1 [2]

(c) **(i)** new flux linkage $= 8.0 \times 10^{-3} \times 0.4 \times 10^{-4} \times 150$
$= 4.8 \times 10^{-5}$ Wb C1
change = 2.52×10^{-4} Wb A1 [2]

(ii) e.m.f. $= (2.52 \times 10^{-4}) / 0.30$ C1
$= 8.4 \times 10^{-4}$ V A1 [2]

(d) *either* flux linkage decreases as distance increases B1
so speed must increase to keep rate of change constant B1 [2]

or at constant speed, e.m.f. / flux linkage decreases as *x* increases (B1)
so increase speed to keep rate constant (B1)

5 **(a)** into (plane of) paper / downwards B1 [1]

(b) **(i)** the centripetal force = mv^2 / r B1
$mv^2/r = Bqv$ hence $q/m = v/r\,B$ (*some algebra essential*) B1 [2]

(ii) $q/m = (8.2 \times 10^6) / (23 \times 10^{-2} \times 0.74)$ C1
$= 4.82 \times 10^7$ C kg^{-1} A1 [2]

(c) **(i)** mass $= (1.6 \times 10^{-19}) / (4.82 \times 10^7 \times 1.66 \times 10^{-27})$ C1
$= 2u$ [2]

(ii) proton + neutron B1 [1]

6 **(a)** pV / T = constant C1
$T = (6.5 \times 10^6 \times 30 \times 300) / (1.1 \times 10^5 \times 540)$ C1
$= 985$ K A1 [3]
(*if uses °C, allow 1/3 marks for clear formula)*

(b) **(i)** $\Delta U = q + w$
symbols identified correctly M1
directions correct A1 [2]

(ii) q is zero B1
is positive *OR* $\Delta U = w$ and U increases B1
ΔU is rise in kinetic energy of atoms M1
and mean kinetic energy $\propto T$ A1 [4]
(*allow 1 of the last two marks if states 'U increases so T rises'*)

7 **(a)** **(i)** *either* probability of decay per unit time *or* $dN/dt = (-)\lambda N$ OR $A = (-)\lambda N$ with symbols explained M1 A1 [2]

(ii) greater energy of α-particle means M0
(parent) nucleus less stable A1
nucleus more likely to decay A1
hence Radium-224 A1 [3]

(b) **(i)** *either* $\lambda = \ln 2 / 3.6$ = 0.193 unit day^{-1} *or* $\lambda = \ln 2 / 3.6 \times 24 \times 3600$ $= 2.23 \times 10^{-6}$ s^{-1} A1 A1 [2]
(*one sig.fig., -1, allow λ in hr^{-1}*)

(ii) $N = \{(2.24 \times 10^{-3}) / 224\} \times 6.02 \times 10^{23}$ C1
$= 6.02 \times 10^{18}$ C1
activity $= \lambda N$
$= 2.23 \times 10^{-6} \times 6.02 \times 10^{18}$ C1
$= 1.3 \times 10^{13}$ Bq A1 [4]

Section B

8 **(a)** + – B1 [1]

(b) **(i)** **1.** 4.5 V B1

2. Use of potential divider formula $9 \times 800 / (800 + 2200)$ C1

2.4 V A1

3. – 9.0 V B1 [4]

(ii) green (*e.c.f. from (a) and (i)3*) B1 [1]

(c) as temperature rises, potential/voltage at B increases M1

at 60 °C, green goes out, red comes on A1 [2]

9 **(a)** **(i)** clear distinction of boundaries between regions B1

(ii) significant difference in blackening of different regions B1 [2]

(b) **(i)** $½ = e^{-\mu}$ C1

$\mu = 0.693\ mm^{-1}$ A1 [2]

(ii) X-ray (photons) are more penetrating M1

μ is smaller A1 [2]

10 **(a)** amplitude of carrier wave varies M1

in synchrony with (displacement of information) signal A1 [2]

(b) three vertical lines B1

symmetrical with smaller sidebands B1

at frequencies 70, 75 and 80 kHz B1 [3]

(c) bandwidth = 10 kHz B1 [1]

11 **(a)** unwanted energy / power that is random or that covers whole spectrum B1 [1]

(b) number of dB = $10 \lg(P_{OUT} / P_{IN})$ C1

$63 = 10 \lg (P_{OUT} / (2.5 \times 10^{-6})$ C1

$P_{OUT} = 5.0$ W A1 [3]

(c) attenuation = $10 \lg(5 / 3.5 \times 10^{-8}) = 81.5$ dB C1

length = 81.5 / 12 = 6.8 km A1 [2]

12 e.g. permits entry to PSTN

selects base station for any handset

allocates a carrier frequency/channel

monitors handset signal to re-allocate base station

allocates time slot for multiplexing etc

(*any four sensible suggestions, 1 each to max 4)* B4 [4]